

## Claims

What is claimed is:

- 1           1.     A scheduling method for implementing Quality-of-Service  
2     (QoS) scheduling of a plurality of flows with aging time stamps comprising  
3     the steps of:  
4         sequentially accessing a subset of time stamp data from a time stamp  
5     aging memory array; each time stamp data subset containing time stamp  
6     data for a subplurality of flows;  
7         performing guaranteed aging processing steps for each flow utilizing  
8     said time stamp data subsets to identify and mark invalid calendar next time  
9     values,  
10        identifying a new frame arrival for an empty flow and accessing time  
11    stamp data from a flow queue control block (FQCB) for said flow and said  
12    flow time stamp data in said time stamp aging memory array;  
13        responsive to said identified new frame arrival for said empty flow,  
14    checking a selection indicator of said time stamp aging memory array data to  
15    identify said target calendar for attaching said flow;  
16        responsive to said selection indicator value, checking a target  
17    calendar next time valid bit of said time stamp aging memory array data for  
18    said flow;  
19        responsive to said target calendar next time valid bit being on,  
20    comparing a target calendar next time from said flow queue control block  
21    (FQCB) for said flow with a current time;  
22        responsive to said target calendar next time being less than said  
23    current time, turning off said target calendar next time valid bit to mark said  
24    target calendar next time as invalid.
- 1           2.     A scheduling method for implementing Quality-of-Service  
2     (QoS) scheduling of a plurality of flows with aging time stamps as recited in  
3     claim 1 includes the steps of storing time stamp data for each flow in said  
4     flow queue control block (FQCB) and in said time stamp aging memory  
5     array; said flow queue control block (FQCB) for each flow stored in external  
6     static random access memory (SRAM) and said time stamp aging memory  
7     array stored in an internal scheduler memory array.

1           3.     A scheduling method for implementing Quality-of-Service  
2     (QoS) scheduling of a plurality of flows with aging time stamps as recited in  
3     claim 2 wherein the steps of storing time stamp data includes the steps of:  
4         identifying a flow for servicing on a calendar and dispatching a frame  
5     from said identified flow;  
6         calculating a calendar next time value for said identified flow; and  
7         storing said calendar next time value for said identified flow in said  
8     flow queue control block (FQCB) for said identified flow; and  
9         storing time stamp data in said time stamp aging memory array; said  
10    stored time stamp data in said time stamp aging memory array including at  
11    least a portion of said calendar next time value; said selection indicator and  
12    said calendar valid bit set to mark said calendar next time as valid.

1           4.     A scheduling method for implementing Quality-of-Service  
2     (QoS) scheduling of a plurality of flows with aging time stamps as recited in  
3     claim 1 wherein said guaranteed aging processing steps for each flow in  
4     said time stamp data subset include the steps of;  
5         checking said selection indicator, said selection indicator indicating a  
6     calendar;  
7         responsive to said selection indicator, checking said calendar next  
8     time valid bit;  
9         responsive to said calendar next time valid bit being on, comparing a  
10    calendar next time with a current time; and  
11         responsive to said calendar next time being less than said current  
12    time, turning off said calendar next time valid bit to mark said calendar next  
13    time as invalid.

1           5.     A scheduling method for implementing Quality-of-Service  
2     (QoS) scheduling of a plurality of flows with aging time stamps as recited in  
3     claim 1 wherein said target calendar is a peak bandwidth service (PBS)  
4     calendar and further include the step responsive to said PBS valid bit being  
5     off, of attaching said flow to a weighted fair queue (WFQ) ring using a queue  
6     distance calculation.

1           6.     A scheduling method for implementing Quality-of-Service  
2     (QoS) scheduling of a plurality of flows with aging time stamps as recited in  
3     claim 1 wherein said target calendar is a peak bandwidth service (PBS)  
4     calendar and further include the step responsive to said PBS valid bit being  
5     on, of attaching said flow to said PBS calendar using a PBS next time value.

1           7.     A scheduling method for implementing Quality-of-Service  
2     (QoS) scheduling of a plurality of flows with aging time stamps as recited in  
3     claim 1 wherein said target calendar is a low latency service (LLS)/normal  
4     latency service (NLS) calendar and further include the step responsive to  
5     said LLS/NLS valid bit being off, of attaching said flow to said LLS/NLS  
6     calendar using said current time value.

1           8.     A scheduling method for implementing Quality-of-Service  
2     (QoS) scheduling of a plurality of flows with aging time stamps as recited in  
3     claim 1 wherein said target calendar is a low latency service (LLS)/normal  
4     latency service (NLS) calendar and further include the step responsive to  
5     said LLS/NLS valid bit being on, of attaching said flow to said LLS/NLS  
6     calendar using a LLS/NLS next time value.

1           9.     A scheduler for implementing Quality-of-Service (QoS)  
2     scheduling of a plurality of flows with aging time stamps comprising:  
3         a queue manager;  
4         a plurality of calendars coupled to said queue manager for scheduling  
5     flows;  
6         a memory coupled to said queue manager for storing a flow queue  
7     control block (FQCB) for each of said plurality of flows;  
8         a time stamp aging memory array coupled to said queue manager for  
9     storing a set of indicator bits and time stamp data for each of said plurality of  
10    flows; said set of indicator bits including a calendar selector and at least one  
11    calendar next time valid bit;  
12         a memory manager for sequentially accessing a subset of time stamp  
13    data from an time stamp aging memory array; each time stamp data subset  
14    containing time stamp data for a subplurality of flows; said memory manager  
15    for performing guaranteed aging processing steps for each flow in each time  
16    stamp data subset to identify and mark invalid calendar next time values,  
17         said queue manager for identifying a new frame arrival for an empty  
18    flow;  
19         said memory manager responsive to said new frame arrival for said  
20    empty flow for accessing time stamp data from a flow queue control block  
21    (FQCB) for said flow and said time stamp data in said time stamp aging  
22    memory array;  
23         said memory manager responsive to said identified new frame arrival  
24    for said empty flow, for identifying a target calendar for attaching said flow;  
25         said memory manager responsive to said identified target calendar,  
26    for checking said target calendar next time valid bit of said time stamp aging  
27    memory array data for said flow;  
28         said memory manager responsive to said target calendar next time  
29    valid bit being on, for comparing a target calendar next time value from said  
30    flow queue control block (FQCB) for said flow with a current time;  
31         said memory manager responsive to said target calendar next time  
32    being less than said current time, for turning off said target calendar next  
33    time valid bit to mark said target calendar next time as invalid.

1           10. A scheduler for implementing Quality-of-Service (QoS)  
2 scheduling of a plurality of flows with aging time stamps as recited in claim 9  
3 wherein said memory coupled to said queue manager for storing a flow  
4 queue control block (FQCB) for each of said plurality of flows includes an  
5 external static random access memory (SRAM).

1           11. A scheduler for implementing Quality-of-Service (QoS)  
2 scheduling of a plurality of flows with aging time stamps as recited in claim 9  
3 wherein said time stamp aging memory array includes an internal memory  
4 array.

1           12. A scheduler for implementing Quality-of-Service (QoS)  
2 scheduling of a plurality of flows with aging time stamps as recited in claim 9  
3 wherein said plurality of calendars coupled to said queue manager for  
4 scheduling flows includes a low latency service (LLS)/normal latency service  
5 (NLS) calendar; a peak bandwidth service (PBS) calendar; and a weighted  
6 fair queue (WFQ) ring.

1           13. A scheduler for implementing Quality-of-Service (QoS)  
2 scheduling of a plurality of flows with aging time stamps as recited in claim  
3 12 wherein said set of indicator bits includes said calendar selector for  
4 selecting said PBS calendar or said LLS/NLS calendar.

1           14. A scheduler for implementing Quality-of-Service (QoS)  
2 scheduling of a plurality of flows with aging time stamps as recited in claim  
3 13 wherein said at least one calendar next time valid bit includes a PBS next  
4 time valid bit and a LLS/NLS next time valid bit.

1           15. A scheduler for implementing Quality-of-Service (QoS)  
2 scheduling of a plurality of flows with aging time stamps as recited in claim  
3 14 wherein said queue manager responsive to said PBS calendar identified  
4 as said target calendar and said PBS next time valid bit being off, for  
5 attaching said flow to said weighted fair queue (WFQ) ring using a queue  
6 distance calculation.

1           16. A scheduler for implementing Quality-of-Service (QoS)  
2 scheduling of a plurality of flows with aging time stamps as recited in claim  
3 14 wherein said queue manager responsive to said PBS calendar identified  
4 as said target calendar and said PBS next time valid bit being on, for  
5 attaching said flow to said PBS calendar using said PBS next time value.

1           17. A scheduler for implementing Quality-of-Service (QoS)  
2 scheduling of a plurality of flows with aging time stamps as recited in claim  
3 14 includes wherein said queue manager responsive to said LLS/NLS  
4 calendar selected as said target calendar and said LLS/NLS next time valid  
5 bit being off, for attaching said flow to said LLS/NLS calendar using said  
6 current time value.

1           18. A scheduler for implementing Quality-of-Service (QoS)  
2 scheduling of a plurality of flows with aging time stamps as recited in claim  
3 14 includes wherein said queue manager responsive to said LLS/NLS  
4 calendar selected as said target calendar and said LLS/NLS next time valid  
5 bit being on, for attaching said flow to said LLS/NLS calendar using said  
6 LLS/NLS next time value.

1           19. A computer program product for implementing Quality-of-  
2 Service (QoS) scheduling of a plurality of flows with aging time stamps in a  
3 scheduler, said computer program product including a plurality of computer  
4 executable instructions stored on a computer readable medium, wherein  
5 said instructions, when executed by said scheduler, cause said scheduler to  
6 perform the steps of:

7           sequentially accessing a subset of time stamp data from an time  
8 stamp aging memory array; each time stamp data subset containing time  
9 stamp data for a subplurality of flows;

10          performing guaranteed aging processing steps for each flow on a  
11 scheduler calendar in each time stamp data subset to identify and mark  
12 invalid calendar next time values,

13          identifying a new frame arrival for an empty flow and accessing time  
14 stamp data from a flow queue control block (FQCB) for said flow and said  
15 time stamp data in said time stamp aging memory array;

16          responsive to said identified new frame arrival for said empty flow,  
17 checking a selection indicator of said time stamp aging memory array data to  
18 identify said target calendar for attaching said flow;

19          responsive to said selection indicator value, checking a target  
20 calendar next time valid bit of said time stamp aging memory array data for  
21 said flow;

22          responsive to said target calendar next time valid bit being on,  
23 comparing a target calendar next time from said flow queue control block  
24 (FQCB) for said flow with a current time; and

25          responsive to said target calendar next time being less than said  
26 current time, turning off said target calendar next time valid bit to mark said  
27 target calendar next time as invalid.

1           20. A computer program product for implementing Quality-of-  
2 Service (QoS) scheduling of a plurality of flows with aging time stamps in a  
3 scheduler as recited in claim 18 wherein said instructions, when executed by  
4 said scheduler, cause said scheduler to perform the steps of storing said  
5 flow queue control block (FQCB) for each of said plurality of flows in an  
6 external memory; and storing a set of indicator bits and time stamp data for  
7 each of said plurality of flows in a time stamp aging memory array, said set  
8 of indicator bits including said selector indicator and said calendar next time  
9 valid bit.